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ABSTRACT

The values of an information service depend primarily upon two things: they either save time or they increase the literature coverage. This study attempts to measure these factors from data gathered by a questionnaire which was sent to a selected group of industrial chemists. Thus the habits of a statistically meaningful sample of industrial chemists in their use of information services were explored and a crude model for at least a semiquantitative determination of the cost-effectiveness of information systems was developed. (Author/NH)

COST EFFECTIVENESS OF INFORMATION SYSTEMS

A report by the Subcommittee
on the Economics of Chemical Information

of the
Committee on Corporation Associates

American Chemical Society

Report to American Chemical Society Corporation Associates

May 20, 1969

COST EFFECTIVENESS OF INFORMATION SYSTEMS

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COST EFFECTIVENESS OF INFORMATION SYSTEMS

In May, 1968, a subcommittee of the Committee on Corporation Associates was established "to study the economics of chemical information activities in industry". This was done in response to a direct request from the ACS Committee on Chemical Abstracts Service for such a study and to meet a general need by the ACS for a way to measure the cost-effectiveness of information services. A preliminary report of the findings of the subcommittee was presented to the Corporation Associates in November, 1968. This is the final report of the subcommittee.

Several previous groups have instituted studies of the economics of information systems. Two major current activities are being carried on, by the Organization for Economic Cooperation and Development and by the Division of Chemistry and Chemical Technology, National Research Council. These studies, as well as some of the earlier ones, have focused on the more manageable problem of developing methods for the measurement of costs of information systems and services. As far as the subcommittee knows, there have as yet been no reports by any of these groups on cost-effectiveness, and the earlier studies were apparently abandoned without reaching any conclusions in the area of cost-effectiveness.

Two reports of interest to the present study have been published. Martyn[1] carried on an extensive study of literature searching by research scientists, to obtain data on the habits of research people in carrying on searches before instituting new projects and the amount of duplication and wastage of time and effort in research projects, as indicated by the later discovery of important references. Brockis and Cole[2] have published a more limited survey of the incidence of late discoveries of important references.

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(1) J. Martyn, "Literature Searching by Research Scientists", Aslib Research Department, London, 1964.

(2)

In view of the apparent adequacy of current efforts and published reports in the cost-measurement area, and the almost complete lack of even qualitative guides for determining the effectiveness of information systems, the subcommittee decided to confine its activities to the latter aspect of the economics problem. The subcommittee was fully aware of the great difficulty it would have in attempting to establish any reasonably satisfactory quantitative measure of effectiveness, but felt that even a very rough estimate would be better than nothing — which is the present state of affairs.

Clearly there are a number of ways in which an information system might be "effective". It can save time, by improving access to the literature. It can make available a greater body of literature, within a given time. This, in turn, leads to the possibility that an important new idea may be stimulated. It can help prevent duplication of research efforts. It can provide specific information required for a research project, or background information needed for entry into a new field. These and other aspects of "effectiveness" were considered, and it was concluded that some may be susceptible to at least a semiquantitative study.

Basically, the values of a service depend primarily upon two things — they either save time or they increase the literature coverage. Obviously these are not entirely independent. A person might, at one extreme, set in effect a time limit for himself and cover as much literature as he could in that time, and, at the other extreme, devote whatever time it took to cover a given amount of literature; or, he could elect an intermediate course, saving some time and extending his literature coverage somewhat. These factors — time saving and greater literature coverage — may be measurable, and this is what the present study attempted to do. More nebulous

values, such as the worth of a brilliant idea that results from improved access to the literature, appear to be impossible to measure and this was not attempted. This may suggest, however, that the values determined in the manner used for this study could constitute a lower bound.

The avoidance of duplication of effort, which was the principal factor studied by Martyn and by Brockis and Cole, is also fairly easily relatable to value, and is in part an alternative approach. If, as hypothesized above, the user keeps constant his total time devoted to the literature and succeeds in increasing his literature coverage by the use of a particular service, he may benefit by being led to a new idea, or by avoidance of duplication and wastage of research effort through discovery of relevant literature. If, on the other hand, the user covers all the relevant literature, no matter what the time required may be, no benefits of these sorts will result from the availability of the service, and the value will be strictly in terms of time saved and the worth of that time. As noted above, an intermediate result will also be expected, frequently.

It was noted also that the use of technical literature falls into two broad categories, described briefly as "current awareness" and "searching". The first of these relates to the need for a scientist or technologist to keep up with the current literature, mainly in his own specialty and in closely related fields, but also to some extent in remoter fields, in search of new ideas and to gain perspective. The second general category is the more or less thorough coverage of the literature, in search of specific information or to provide a survey of all the work in a given area.

In order to obtain data of the kind described, a questionnaire was prepared and sent to a selected group of industrial chemists. The first version was sent to people

in the companies represented on the Committee on Corporation Associates, and an amended and revised version was later sent to a much larger group of people, in all the companies which are Corporation Associates. In each mailing, the company representative on the Corporation Associates was asked to solicit responses from ten of his associates, selected in as random a manner as was convenient from among his company's professional "research" chemists. This would be expected to include many development chemists, but was intended to exclude a number of people such as technical sales, information specialists, etc. The preliminary survey went to 150 chemists, with 135 usable responses received. The second went to 2790 chemists, with 1394 usable responses. The sample sizes are generally large enough to permit statistically meaningful conclusions to be drawn.

The second questionnaire is attached. (The first version was similar in concept and differed only in its details.) The first page asked for background information on the respondent and his company, to permit a later breakdown of the results according to the subcategories indicated. The second page asked for data on the use of information services. Sources of information were divided into seven groupings: Primary sources, Books and reviews, Abstract services, Title services, Science Citation Index, Patent services, and Computerized information services. The respondent was asked to: (1) indicate which groups of services were available to him; (2) estimate the number of hours per week spent using each of the groups of services, for both Current Awareness and for Searching (separately); (3) estimate the number of hours per week he saved through the use of each of the categories of services available to him, again for both the Current Awareness and Searching functions (omitting Primary Sources, and Books and Reviews); (4) estimate the percentage increase in his

coverage of useful literature through the use of each of the categories of services available to him, for Current Awareness and for Searching.

The profile data for the respondents and their companies are as follows:

Age	
Under 30	214
31-40	591
41-50	389
Over 50	196
(no reply	4)

Highest Degree	
None	21
Bachelor's	367
Master's	230
PhD/DSc	768
Other	7
(no reply	1)

Years of Experience	
Under 5	268
5-10	309
10-20	515
20-30	215
Over 30	84
(no reply	3)

Number of People Reporting to the Respondent	
None	268
1-3	612
4-10	322
11-20	125
Over 20	66
(no reply	1)

*Field of Specialization	
Organic	650
Physical	261
Analytical	232
Inorganic	146
Biological	120
Medicinal	122
Plastics	181
Petroleum	87
Engineering	139
Other	234

Field of Activity	
Research	962
Development	333
Administration	72
Other	71

(*Multiple responses allowed)

*Principal Business of Company		Size of Company - annual sales	
Chemicals	599	Under $10 million	60
Plastics	160	$10-100 million	308
Rubber	65	Over $100 million	990
Drugs	211	(no reply	14)
Electrical	76		
Metals	85		
Petroleum	121		
Other	544		
(no reply	2)		

(*Multiple responses allowed)

The availability of categories of information services was found to be:

Abstract services	92%
Title services	76%
Science Citation Index	20%
Patent services	84%
Computerized information services	32%

It was apparent that a number of respondents did not really know whether or not they had Science Citation Index available. It was also evident that the computerized information services were more likely to be available in large companies than in small ones (38% in companies with sales over $100 million vs. 17% in those under $100 million).

The percentages of people using each of the services available to them were as follows:

	Current Awareness	Searching	Either Usage
Abstract services	67%	80%	93%
Title services	52%	29%	62%
Science Citation Index	11%	21%	24%
Patent services	63%	45%	68%
Computerized information services	42%	39%	60%

The low usage of Science Citation Index undoubtedly reflects a general unfamiliarity with this service, since users of it find it to be highly effective. This suggests that many people not using Science Citation Index would find it profitable to learn to use it. It is perhaps somewhat surprising that the percentage using available computerized services is not higher.

The time spent by chemists in their use of information sources is of considerable interest. The data indicate that this time is rather higher than is generally thought:

	Current Awareness (hrs/week)	Searching (hrs/week)
Primary sources	4.2	1.6
Books and reviews	1.5	1.2
Abstract services	0.8	1.1
Title services	0.4	0.2
Science Citation Index	0.1	0.1
Patent services	0.6	0.4
Computerized services	0.3	0.2

The numbers for Primary sources and for Books and reviews are averages for all respondents, as it was assumed that everyone had access to these. The figures for the other categories are averages for all people who have access to these services, including those who do not use them. If the averages are taken only for those using the services, the results are:

	Current Awareness (hrs/week)	Searching (hrs/week)
Abstract services	1.3	1.4
Title services	0.9	0.7
Science Citation Index	0.6	0.5
Patent services	0.9	0.8
Computerized services	0.8	0.7

The averages cannot be added, in either of the above tables, because the separate figures refer to somewhat different populations.

Averages computed for all 1394 respondents, whether or not they have a particular service, give a figure for the average time spent using information sources by all industrial chemists. These numbers are 7.5 hrs/week for Current Awareness and 4.3 hrs/week for Searching, for a total time of 11.8 hrs/week. No important differences between people in large and small companies appeared. There were some differences between people in various subfields of chemistry. Organic chemists and biological/medicinal chemists spend more time with information sources than do chemists as a whole; the figures for organic chemists total 13.2 hrs/week, and for biological/medicinal chemists 13.7 hrs/week. Research people spend more time on information than do non-research chemists, totaling 12.6 hrs/week as compared with 10.2 hrs/week for non-research chemists. People in chemical companies spend slightly more time than the average chemist surveyed, 12.3 hrs/week. People in drug companies spend considerably more time, 13.3 hrs/week.

Estimates of time saved, through the use of a particular information service, are of course difficult for anyone to make. A few respondents pointed out (correctly of course) that these quantities were "impossible to estimate"; most respondents made the attempt, however. The hope was that there would be no systematic tendency to overestimate or underestimate this quantity, and that the averages would therefore have at least a rough quantitative validity. In full realization of the very limited accuracy of the data, then, the following results are presented:

	Current Awareness (hrs/week)	Searching (hrs/week)
Abstract services	3.2	3.9
Title services	2.6	1.8
Science Citation Index	1.6	1.3
Patent services	2.0	2.1
Computerized services	2.5	3.1

These averages are for people actually using the service.

A measure of the effectiveness of each service can be obtained by comparing these estimates of time saved with the earlier figures reported for time spent. Thus the ratio of the two gives an estimate of the number of hours saved for each hour spent, with a given service. For example, Abstract services for Searching are said to save 4.0 hrs/week by the expenditure of 1.4 hrs/week; this is 2.9 hours per hour spent. (Obviously the time saved, or the effectiveness, of a particular service will also depend to some extent upon what other services are used, etc.) By this criterion the order of effectiveness of information services is:

Current Awareness	(hrs/week)	Searching	(hrs/week)
Computerized services	3.1	Computerized services	4.8
Title services	2.9	Abstract services	2.8
Science Citation Index	2.7	Science Citation Index	2.7
Abstract services	2.5	Title services	2.6
Patent services	2.1	Patent services	2.6

Small differences in these numbers are not meaningful in measuring order of effectiveness.

The questionnaire also asked for an estimate of the percentage increase in the coverage of useful literature by the use of information service. The results for Current Awareness were: Abstract services 90%, Title services 90%, Computerized services 90%, Patent services 70%, and Science Citation Index 20%. For Searching, the results were: Abstract services 140%, Computerized services 100%, Title services 70%, Patent services 70%, and Science Citation Index 50%. It is felt that these data may be rather unreliable, as a number of respondents indicated considerable difficulty in making some of the estimates. For example, the increased coverage is probably more apparent to the user of Abstract services for Searching than is Science

Citation Index, although other studies[3] of this comparison indicate that for short searches Science Citation Index is actually more efficient, and they are about equal in the long run.

Finally, as an exercise to see what value might be placed upon a particular category of service, we can use the data for Computerized services. A total of 440 respondents have them available (less than half of these people actually use the services, as noted above). They say that their use of Computerized services results in a time saving of 996 hours (455 for Current Awareness, 541 for Searching). These numbers thus indicate that the provision of Computerized services to an average group of industrial chemists will result in a time saving of 2.3 hrs/week (996/440), averaged over all the staff, i.e., including those who do not use the services as well as those who do. Obviously the figure would be higher if more of the staff used these services. Thus the "value" of Computerized services for, say, a staff of 100 chemists costing $20/hour (including overhead) for a year would be 100 x 2.3 x 20 x 52 = $250,000/year. It can be argued that this is a lower bound to the value, since no allowance has been made for the value of increased literature coverage. On this basis, it might be legitimate to use this "value" in a comparison with the costs for computerized services, to determine cost-effectiveness.

Similar calculations could be made for the other categories of services. The time saved, averaged over all staff members, is as follows: Abstract services 5.4 hrs/week, Title services 1.9 hrs/week, Science Citation Index 0.4 hrs/week, and Patent services 2.2 hrs/week. Again, these numbers represent a combination of two factors, one being the fraction of the people using the service and the other the estimate of time saved by those actually using it. Clearly, low fractional usage has drastically reduced some of these numbers.

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3) C. C. Spencer, American Documentation, April 1967.

In summary, we have explored the habits of a statistically meaningful sample of industrial chemists in their use of information services, and have developed a crude model for at least a semiquantitative determination of the cost-effectiveness of information systems.

N. B. HANNAY (Chairman)
May 20, 1969

Questionnaire on Information Services

ACS Corporation Associates

Please X appropriate squares (mark only one square, except where indicated).

(Please leave blank) (1)(2)(3)(4)

	0
	1
	2
	3
	4
	5
	6
	7
	8
	9

Your Age (5)

Under 30	0
31-40	1
41-50	2
Over 50	3

Highest Degree (6)

None	0
Bachelor's	1
Master's	2
Ph.D./D.Sc.	3
Other	4

Years of Experience (after degree) (7)

Under 5	0
5-10	1
10-20	2
20-30	3
Over 30	4

How many people report to you (non-clerical) (8)

None	0
1-3	1
4-10	2
11-20	3
Over 20	4

Field of Specialization (X no more than two squares) (9-10)

Organic	0
Physical	1
Analytical	2
Inorganic	3
Biological	4
Medicinal	5
Plastics	6
Petroleum	7
Engineering	8
Other	9

Field of Activity (11)

Research	0
Development	1
Administration	2
Other	3

Principal Business of Company (X no more than two squares) (12-13)

Chemicals	0
Plastics	1
Rubber	2
Drugs	3
Electrical/electronic	4
Metals	5
Petroleum	6
Other	7

Size of Company (annual sales) (14)

Under $10 million	0
$10 - 100 million	1
Over 100 million	2

Use of Information Sources and Services (including in-house services)

Please fill in as many boxes as possible — even rough estimates will be useful.
Give hours/week to nearest tenth (e.g., 2.5).
If you do not use a service you have, enter "0" in the appropriate box in column B or C.
If you are unable to make any of the estimates in columns D through G, enter "N" in the appropriate box.

	A	B	C	D	E	F	G
	Check (X) Services Available to you	(Average) Hours/Week Used: for Current Awareness	for Searching	Estimate hrs./wk. saved by your present use of each category of service now available to you (rows 3 through 7) for Current Awareness	for Searching	Estimate the per cent increase in your coverage of useful literature by your use of this service (no increase = 0%) for Current Awareness	for Searching
1. Primary sources (journals, trade papers, meeting preprints, etc.)		(20)	(20)				
2. Books and Reviews		(23)	(23)				
3. Abstract services (e.g., POST, Chemical Abstracts, Ringdoc, etc.)	(15)	(26)	(26)	(41)	(41)	(61)	(61)
4. Title services (e.g., Chemical Titles, Current Contents, etc.)	(16)	(29)	(29)	(45)	(45)	(65)	(65)
5. Science Citation Index	(17)	(32)	(32)	(49)	(49)	(69)	(69)
6. Patent services (Abstracts, Indexes, Derwent, etc.)	(18)	(35)	(35)	(53)	(53)	(73)	(73)
7. Computerized information services*	(19)	(38)	(38)	(57)	(57)	(77)	(77)

*(selective dissemination of information of the kinds listed in rows 3-6 according to user interest profiles, or for searching)